Comparison of Three Techniques for Ultrasound Guided Internal Jugular Vein Cannulation

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ABSTRACT

BACKGROUND

In any given hospital set up, obtaining venous access is of utmost significance. Central venous catheterization is now an unavoidable component for invasive monitoring and management. Central venous access was first given by Aubaniac[1] in 1953. Cannulation of the internal jugular vein is a procedure commonly performed by anaesthetists, in both the perioperative period and in intensive care.[2] The internal jugular route for central venous access has been described as early as in 1966 by Hermosura.[3] The very first and one of the most commonly followed method for central venous catheterization remains a blind surface landmark-guided technique. Ultrasonography guidance in central venous cannulation has converted a blind procedure into a procedure under vision which helps in reducing the complication rates. The aim of the study is to compare three ultrasound guided techniques (short axis vs long axis vs oblique axis) for cannulation of the right internal jugular vein.

METHODS

This is an observational study conducted among 151 patients who fulfilled the inclusion criteria and who had given a written informed consent. The patients were divided into groups of 51 each. Group 1- Short axis approach (SAX), Group 2- Long axis approach (LAX), Group 3- Oblique axis approach (OAX). The outcome variables used were- 1. Successful cannulation with the designated approach, 2. First needle pass success n (%), 3. Number of needle passes, 4. Cannulation time (s). 5. Complications.

RESULTS

The findings of the study indicate that Oblique axis approach to IJV cannulation is better than Long or Short axis approach in terms of number of needle passes, first needle pass success, and cannulation time . There was no statistically significant difference in complication rates among the three groups.

CONCLUSIONS

It can be concluded that while performing ultrasound guided Internal Jugular Vein cannulation, the Oblique axis approach can be considered as a safe and effective approach.

KEYWORDS

Ultrasound-Guided, Central Venous Cannulation, Short Axis, Internal Jugular Vein

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BACKGROUND

A number of central venous cannulation are done annually by the clinicians, which facilitates resuscitation, nutritional support, and long-term vascular access.[4] Central venous access was first introduced by Aubaniac in 1953. In the following year Seldinger[5] modified the technique of catheter insertion by passing a guide wire through the needle and threading the catheter over the guide wire. This technique became popular worldwide and now goes by the name Seldinger Technique. Various other routes of central venous access were described subsequently in the next decades. Complications Of Central Venous Catheterization[6,7] can include Lung injury, Haematoma, Arterial injury/cannulation etc.

One of the most common complication seen associated with central venous catheterization is carotid artery puncture. It occurs in 6% to 25%[8,9] of individuals undergoing the procedure. In 1984, Legler and Nugent first reported two-dimensional ultrasound and doppler techniques for internal jugular vein (IJV) cannulation.[10,11] Later on, real time sonography guidance for visualizing the vein and catheterization superseded the use of doppler guided vascular access.[11] Ultrasound guidance has shown to decrease the venous access time, number of needle passes and the incidence of mechanical complications, improves overall and first attempt success rates. Three transducer orientation approaches (SAX, LAX and OAX) have been proposed for IJV cannulation. This study was designed to compare the performance of three transducer orientation approaches (SAX, LAX and OAX) for ultrasound-guided internal jugular venous access.

METHODS

Approval from Local Ethics and Research Committee and written informed consent from patients were obtained. An observational study was performed on One hundred and fifty-three patients, indicated for internal jugular vein cannulation, in multiple centres across South Kerala during 12 months from June 2018 to May 2019. Sample size was calculated as 153 with 51 in each group. The vascular puncture was performed using a single-person technique (with the same operator handling the transducer and the needle). Patients were divided into three groups- Group 1-Short axis approach (SAX), Group 2- Long axis approach (LAX), and Group 3-Oblique axis approach (OAX)

Inclusion Criteria

- Patients aged 18 years or older.
- Indicated for internal jugular venous cannulation.
- Informed consent.

Exclusion Criteria

- Infection near puncture site.
- Cutaneous erosions or subcutaneous haematoma /emphysema or previous surgical interventions at cannulation site.
- Recent right IJV cannulation.
- Recent cervical trauma, cervical spinal injury.
- Severe coagulopathy.

Relevant Demographic data was recorded. During procedure ECG, respiratory rate, oxygen saturation and non-invasive blood pressure were monitored. Under strict aseptic precautions Right internal jugular cannulation performed using the "Seldinger" technique with a 18-G, 6.5 cm introducer needle with a 5 ml syringe attached to it. Patients were placed in Trendelenburg position with the head turned to the left.

Ultrasound device (LOGIQ US System) with 7.5 MHz linear transducer was used. The ultrasound probe was covered with a sterile sheath and sterile ultrasound gel was applied to both the inside and outside of the sheath.

Short Axis Technique

The transducer in a transverse orientation on the patient's neck at the level of the cricoid cartilage and an axial (cross-sectional) image of the internal jugular vein was obtained. The skin pierced with the needle placed at an angle of at least 45 degrees to the transducer and advanced toward the vein employing gentle aspiration on the attached syringe. Entry to the vein was confirmed by visualizing indentation of the anterior wall of the vein followed by blood in the syringe.

Long Axis Technique

The probe was centered on the internal jugular vein (Axial view) and rotated through 90 degree in a clockwise direction resulting in a long axis image of the vein. The needle was inserted from directly beneath the most proximal end of the ultrasound probe. The needle was inserted at 30 degree to the vertical and advanced toward the vein employing gentle aspiration. Position in vein was confirmed by visualizing needle entry into the vein and aspiration of blood in the syringe.

Oblique Axis Technique

An axial (short axis) view was first obtained. The probe was centered on the internal jugular vein and rotated through 45 degree in a clockwise direction resulting in an oblique axis image of the vein. Entry to the vein was confirmed by visualizing indentation of the anterior wall of the vein followed by blood in the syringe. After the vessel is entered, place the guide wire using the Seldinger technique. Confirmation of guide wire placement in the internal jugular was performed by rescanning the vein.

Final insertion depth was kept as per the Peres' formula (height/10) (in cm). Post procedure chest x-ray was taken to detect pneumothorax and malposition of tip of catheter.

During catheterization the following outcome variables were recorded-

1. Successful cannulation with the designated approach. Cannulation was considered "unsuccessful" If time spent until guide wire insertion was more than 180 seconds, or if guide wire cannot be inserted into the internal jugular vein chosen.
2. First needle pass success.
3. Number of needle passes.
4. Cannulation time (s)
   Time taken (seconds) for the Seldinger needle pierces the skin up to the moment the guide wire was inserted inside the vein.
5. Complications.

For analysis of the data Statistical Package for the social sciences (SPSS) version 21.0 was used. The Data for statistical analysis are presented as mean ± standard deviation. Comparison of outcomes were done using Chi square test of homogeneity, Duncan's post hoc test and ANOVA.

RESULTS

Figure 1 shows the flow of participants through each stage of the study. Hundred and fifty three patients completed the study. They were then analysed. The demographic data among the 3 groups showed no statistically significant differences (P >0.05) (Table 1).

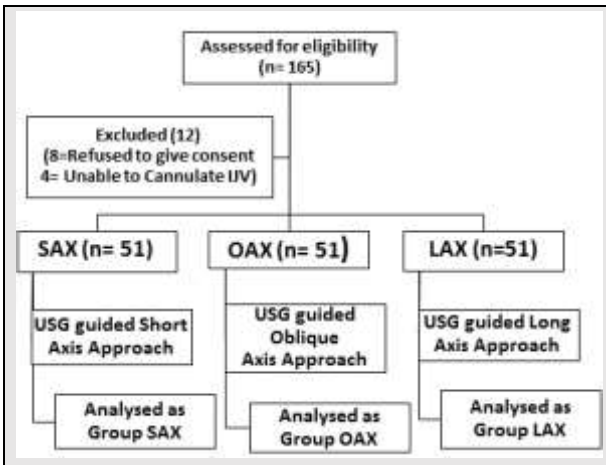

Figure 1

Parameters	SAX	OAX	LAX	P-Value
Age	53.52 ± 6.02	54.43 ± 6.48	56.05±7.12	0.146
BMI	26.63±2.29	27.20±2.22	27.27±1.95	0.264

Table 1. Demographic Variables

NS: Not Significant (P>0.05), *: Significant (P<0.05)

Outcomes

1. Cannulation Success

There was no association between the three groups in terms of cannulation success. Majority of patients in the three groups have reported successful cannulation. Overall cannulation success rate in the designated approaches were 97%. [Fisher's exact test =0.680, P=1.00 (not significant)]. Table 2 shows the Data and test of significance of the comparison of groups based on successful cannulation.

Group	No (%)	Yes (%)	Total
SAX	2 (3.90)	49(96)	51
LAX	1(2)	50(98)	51
OAX	1(2)	50(98)	51
Total	4(2.6)	149(97.3)	153

Table 2. Data and Test of Significance of the Comparison of Groups Based on Successful Cannulation

Fisher's exact test = 0.680, P=1.000 (Not Significant, P>0.05)

2. First Needle Pass Success

First needle pass turned out to be significantly better in OAX group (88.20%) as compared to others. From table 3, it is observed that there exist significant association between three intervention approaches and first needle pass success (chi square =6.382, P<0.05).

Group	No (%)	Yes (%)	Total
SAX	7(13.7)	44(86.3)	51
LAX	15(29.4)	36(70.6)	51
OAX	6(11.8)	45(88.2)	51
Total	28(18.3)	125(81.7)	153

Table 3. Data and the Test of Significance of the Comparison of Groups Based on First Needle Pass Success

Chi square= 6.382; p= 0.049 (Significant p< 0.05)

3. Number of Needle Passes

There existed significant mean differences in the number of needles passes in patients belonging to the three intervention approaches (F=14.408, P<0.05). LAX group reported higher number of needle passes (Table 4).

Variable	Group	N	Mean	SD	F	P
No. of Needle Passes	SAX	51	1.57	0.57	14.408	0.000*
	LAX	51	1.82	0.52		
	OAX	51	1.27	0.45		
	Total	153	1.56	0.56		

Table 4. Data and Test of Significance of the Comparison of Groups Based on Number of Needle Passes

*: Significant (P<0.05), Means show significant variation between respective groups by Duncan's post hoc test

4. Cannulation Time

As seen in Table 5; ANOVA test showed that there existed significant differences in Cannulation times between the different approaches (F= 171.154; p <0.05), with SAX approach taking the least time and LAX approach taking the longest time for cannulation.

Variable	Group	Mean	SD	F	P
Cannulation Time (Seconds)	SAX	36.12	2.87	171.154	0.000*
	LAX	46.73	2.97		
	OAX	41.69	2.85		
	Total	41.51	5.21		

Table 5. Comparison of Cannulation Times

*: Significant (P<0.05), Duncan's post hoc test

5. Adverse Effects

Overall percentage of local cervical hematoma in the designated approaches was 4.60%, p =0.999 (not significant), which shows that there was no association Between the three interventions in terms of local cervical hematoma (figure 3). There was no statistically significant difference in Arterial puncture among the three different approaches.

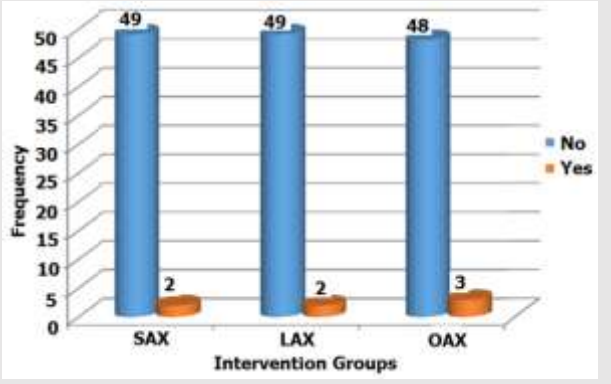

Figure 3. Comparative Bar Chart of Intervention Groups Based on Local Cervical Haematoma

DISCUSSION

The traditional approach to IJVC is based on anatomical landmarks, but current evidence-based recommendations state that ultrasound should be used whenever possible to guide this procedure.[12,13] This increases the success rate, reduces the time and number of attempts until successful cannulation and reduces the incidence of mechanical complications when compared with the traditional landmark technique.[14] Although ultrasound scanning of the targeted vessel before performing needle insertion without ultrasound control (ultrasound assistance) may be helpful, real-time ultrasound control of the needle tip during the actual vascular puncture (ultrasound guidance) is the gold standard of practice.[12]

Among the different imaging approaches described, the short-axis approach (SAX) allows simultaneous visualization of both artery and vein, but can make needle tip control difficult.[15] The long-axis approach (LAX) can optimize needle visualization, but it can be challenging to perform owing to certain anatomical limitations (such as neck length). However accidental arterial cannulation can occur. The oblique-axis approach (OAX) tries to take advantage of the strengths of both previous approaches using a probe alignment that is midway between SAX and LAX, and combines it with an in-plane needle insertion in which the needle is advanced from lateral to medial. Studies comparing transducer orientation approaches for ultrasound-guided IJVC in the clinical setting are scarce. The purpose of the present study was to assess and compare the performance of these approaches (SAX, LAX and OAX) in terms of cannulation success and incidence of complications.

Demographic Variables

The mean age of patients who underwent the short axis (SAX) approach was 53.52 years, for the long axis (LAX) approach was 56.05 years and for oblique axis (OAX) approach was 54.43 years. There was no statistically significant difference in age between these three groups (p= 0.146). The short axis group had an average BMI of 26.63. In the long axis group it was 27.27. In oblique axis it was 27.20. There was no statistically significant difference in BMI between the three groups. (p=0.264)

Clinical Variables

1. Successful Cannulation

SAX group had 96.1% successful cannulation, LAX group had 98% successful cannulation and OAX group had 98% successful cannulation. There was no association between the three interventions in terms of cannulation success. Batllori Met al[16] in a similar study has shown that there was 97% overall cannulation success.

2. First Needle Pass Success

First needle pass failure was significantly higher in the LAX group than in the OAX and SAX group. The study results compare favourably with Batllori M et al[16] who reported similar first needle pass success rate.

3. Number of Needle Passes

Data revealed that patients in the LAX group required more needle passes than patients in the OAX group and SAX group (Statistically significant). Tarek F Tammam et al[17] in their study had documented the average number of attempts in short axis as 1.13±0.35 and long axis as 1.17±0.38, though the difference was not significant .

4. Cannulation Time

Mean cannulation time (s) in SAX group was 36.12± 2.87, in LAX group was 46.73 ± 2.97 and in OAX group was 41.69 ± 2.85. Mean cannulation time was greater in LAX than in SAX and OAX group which was statistically significant. However, in Suresh Chittoodan et al cannulation time was 39.6 ±18.4 seconds versus 46.9 ± 42.4 seconds in short axis and long axis, though the difference was not significant.

5. Complications

Complications were reported rarely.

6. Local Cervical Hematoma

There was no association between the three interventions in terms of local cervical hematoma. Batllori et al[16] in his study shows that short axis group patients had 1 local cervical hematoma and long axis and oblique axis had 2

local cervical haematomata, with p value (0.872), which is not significant.

7. Arterial Puncture

There was no statistically significant association between the three interventions in terms of arterial puncture. Madhavi Sanjay Chaudhari et al[18] in his study had 4 arterial punctures in ultrasound guided short axis group and no arterial puncture in long axis group, which was different from our study. Suresh Chittoodan et al in his study had 4% inadvertent arterial puncture in long axis approach and no arterial puncture on short axis, which was similar to our study.

CONCLUSIONS

The findings of the study indicate that Oblique axis approach to IJV cannulation is better than Long axis and Short axis approach in terms of cannulation quality outcomes (number of needle passes, first needle pass success, cannulation time). Hence, it should be considered as a safe and effective approach to performing internal jugular vein cannulation.

REFERENCES

[1] Nagar VS, Patel DV, Sajjan B, et al. central venous catheterisation- perils and pitfalls in critical care. J Evolution Med Dent Sci 2017;6(23):1890-1893.

[2] Chittoodan S, Breen D, O'Donnell BD, et al. Long versus short axis ultrasound guided approach for internal jugular vein cannulation: a prospective randomised controlled trial. Medical Ultrasonography 2011;13(1):21-25.

[3] Hermosura B, Vanags L, Dickey MW. Measurement of pressure during intravenous therapy. JAMA 1966;195(4):321.

[4] Bannon MP, Heller SF, Rivera M. Anatomic considerations for central venous cannulation. Risk Manag Healthc Policy 2011;4:27-39.

[5] Seldinger SI. Catheter replacement of the needle in percutaneous arteriography: a new technique. Acta Radiologica 1953;39(5):368-376.

[6] Yilmazlar A, Bilgin H, Korfali G, et al. Complications of 1303 central venous cannulations. J R Soc Med 1997;90(6):319-321.

[7] Bethea JW. Clinical anesthesia, 6th edition. Anesthesiol J Am Soc Anesthesiol 2010;112(3):767-768.

[8] Schummer W, Schummer C, Fröber R. Internal jugular vein and anatomic relationship at the root of the neck. Anesth Analg 2003;96(5):1540.

[9] Oliver WC, Nuttall GA, Beynen FM, et al. The incidence of artery puncture with central venous cannulation using a modified technique for detection and prevention of arterial cannulation. J Cardiothorac Vasc Anesth 1997;11(7):851-855.

[10] Salman M, Potter M, Ethel M, et al. Recurrent laryngeal nerve injury: a complication of central venous catheterization-a case report. Angiology 2004;55(3):345-346.

[11] Eisen LA, Narasimhan M, Berger JS, et al. Mechanical complications of central venous catheters. J Intensive Care Med 2006;21(1):40-46.

[12] Troianos CA, Hartman GS, Glas KE, et al. Special articles: guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. Anesth Analg 2012;114(1):46-72.

[13] Lamperti M, Bodenham AR, Pittiruti M, et al. International evidence-based recommendations on ultrasound-guided vascular access. Intensive Care Med 2012;38(7):1105-1117.

[14] Karakitsos D, Labropoulos N, De Groot E, et al. Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients. Crit Care 2006;10(6):R162.

[15] Akhtar MI, Hamid M. Ultrasound guided central venous access; a review of literature. Anaesth Pain & intensive Care 2015;19(3):317-322.

[16] Batllori M, Urra M, Uriarte E, et al. Randomized comparison of three transducer orientation approaches for ultrasound guided internal jugular venous cannulation. Br J Anaesth 2016;116(3):370-376.

[17] Tammam TF, El-Shafey EM, Tammam HF. Ultrasound-guided internal jugular vein access: comparison between short axis and long axis techniques. Saudi J Kidney Dis Transplant 2013;24(4):707-713.

[18] Chaudhari MS, Shah SB, Kamat HV. Ultrasound guided internal jugular vein cannulation with short and long axis approach- technical ease and complications. Indian Journal of Clinical Anaesthesia 2016;3(4):546-550.